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## **Consequences of stroke in community-dwelling elderly: the health and retirement study, 1998 to 2008**

Divani, A A ; Majidi, S ; Barrett, A M ; Noorbaloochi, S ; Luft, A R

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# Consequences of Stroke in Community-Dwelling Elderly

## The Health and Retirement Study, 1998 to 2008

Afshin A. Divani, PhD; Shahram Majidi, MD; Anna M. Barrett, MD;  
Siamak Noorbaloochi, PhD; Andreas R. Luft, MD

**Background and Purpose**—Stroke survivors are at risk of developing comorbidities that further reduce their quality of life. The purpose of this study was to determine the risk of developing a secondary health problem after stroke.

**Methods**—We performed a case-control analysis using 6 biennial interview waves (1998 to 2008) of the Health and Retirement Study. We compared 631 noninstitutionalized individuals who had a single stroke with 631 control subjects matched for age, gender, and interview wave. We studied sleep problems, urinary incontinence, motor impairment, falls, and memory deficits among the 2 groups.

**Results**—Stroke survivors frequently developed new or worsened motor impairment (33%), sleep problems (up to 33%), falls (30%), urinary incontinence (19%), and memory deficits (9%). As compared with control subjects, the risk of developing a secondary health problem was highest for memory deficits (OR, 2.45; 95% CI, 1.34 to 4.46) followed by urinary incontinence (OR, 1.86; 95% CI, 1.31 to 2.66), motor impairment (OR, 1.61; 95% CI, 1.16 to 2.24), falls (OR, 1.5; 95% CI, 1.12 to 2.0), and sleep disturbances (OR, 1.49; 95% CI, 1.09 to 2.03). In contrast, stroke survivors were not more likely to injure themselves during a fall (OR, 1.14; 95% CI, 0.72 to 1.79). After adjusting for cardiovascular risk factors, social status, psychiatric symptoms, and pain, the risks of falling or developing sleep problems were not different from the control subjects.

**Conclusions**—The risk of developing a secondary health problem that can impact daily life is markedly increased after stroke. A better understanding of frequencies and risks for secondary health problems after stroke is necessary for designing better preventive and rehabilitation strategies. (*Stroke*. 2011;42:1821-1825.)

**Key Words:** fall-related injuries ■ falling ■ memory deficit ■ motor impairment ■ risk factors ■ sleep problems ■ stroke ■ urinary incontinence

Stroke is the most frequent cause of adult disability and the third cause of reduced quality of life, after depression and heart attack, in the elderly.<sup>1</sup> The quality of life of a stroke survivor is reduced by permanent neurological disability. Associated health problems further diminish quality of life and worsen over time.<sup>2</sup> The complaints of stroke survivors are manifold and a challenge for physicians. Most common comorbidities are falling, urinary incontinence (UI), sleep disturbances, depression, gait impairment, and cognitive deficits. Several cross-sectional studies have investigated these conditions.<sup>3-9</sup> The conditions may pre-exist, worsen after stroke, or develop over time. For example, falls are a consequence of stroke-related locomotor deficits or the result of gait disturbances due to progressive subcortical vascular encephalopathy, which often causes additional cognitive and emotional dysfunction.<sup>10</sup> Therefore, longitudinal studies are invaluable to estimate the prevalence of these conditions and their risks for the stroke survivors. Several existing longitu-

dinal studies are limited by small sample size, focus on a single stroke-related health problem, or lack an appropriate control group.<sup>3,11-14</sup> Comparison of stroke survivors with nonstroke control subjects is critical to validate examination of comorbidity risks associated with poststroke life.

The Health and Retirement Study (HRS) provides longitudinal data derived from a large and well-characterized cohort. Such data sets are a unique epidemiological source that can indicate possible causal relationships between stroke and other chronic conditions. The objective here was to estimate the effect of stroke on the risk of developing common comorbidities among noninstitutionalized subjects.

### Methods

We used the HRS database to identify health conditions in individuals with and without a history of stroke. Detailed information on HRS can be found elsewhere.<sup>15</sup> Briefly, the HRS is a national longitudinal cohort study investigating noninstitutionalized elderly

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Americans who were >50 years at the time of first interview. The study is conducted as a collaborative effort between the Institute for Social Research at the University of Michigan and the National Institute on Aging. Information on health, economic status, and social status is collected using standard questionnaires. Data are gathered by telephone and face-to-face interviews. Proxy interviews are obtained when study participants are unable to respond for themselves. The HRS uses a national area probability sample of US households with supplemental oversamples of blacks, Hispanics, and residents of the state of Florida. Based on the 1991 Current Population Survey, approximately 19.2% of the US households were expected to be eligible for HRS.<sup>3,15</sup> A follow-up interview wave (IW) is conducted every 2 years.

The analyses reported here used 5 biennial IWs to extract sampled subject with and without a history of stroke. Stroke subjects were defined as subjects who had a first-ever stroke in 1 of the IW between 1998 (fourth IW) and 2006 (eighth IW). Control subjects were randomly selected from a cohort matched for age ( $\pm 5$  years), gender, and IW. Subjects who were not available for interview or were institutionalized post-IW were excluded from the analysis.

Demographic data (age, race, and gender), living arrangement, self-reported health problems (motor impairment, impaired vision and/or hearing, UI, pain, falling, number of falls, and injury due to a previous fall and fractured hip) were extracted. In HRS, hearing and vision were scored as excellent, very good, good, fair, poor, or legally blind or deaf, respectively. We classified the subjects as having vision impairment if they were scored as poor or legally blind. Subjects with poor hearing or deaf score were recorded as having hearing impairment. We also analyzed conditions including neurological or psychiatric disease, memory deficits, diabetes mellitus, cancer, and lung disease if subjects reported that a physician has given them 1 of these diagnoses. In addition, we included the mode of interview (face-to-face or telephone interview) and the respondent (self or proxy) in the analysis.

Motor impairment was scored 0 to 4, depending on the number of positive responses to the following questions: (1) "Can you sit for 2 hours?" (2) "Can you get up from a chair?" (3) "Can you stoop, kneel, or crouch?" (4) "Can you push or pull a large object?"

Subjects were considered as having UI if they reported the involuntary loss of urine within the past 12 months. Subjects were considered to have sleep disturbances if they responded "most of the time" to 1 of the following questions: "Do you have trouble falling asleep?," "Do you have trouble waking up early?," "Do you have trouble waking up at night?," and "How often do you not feeling rested in the morning?" Subjects were considered as having memory deficits if they positively answered the question: "Has a doctor told you that you have a memory-related disease?"

We used 2 sampling strategies to identify different cohorts of stroke subjects in the database: (1) the cross-sectional cohort: health conditions were recorded from the same IW having a reported stroke event; and (2) the longitudinal cohort: health conditions were identified from the IW immediately after the 1 with the reported stroke, excluding all those who had already reported the health condition in the same or prior IW relative to the stroke event. Although in the first sampling strategy, the chronological order of stroke and onset of the health condition was uncertain in the same IW, the second sampling strategy ensured that the health condition developed after the subject had a stroke.

We analyzed the prevalence and the risk of developing 1 of 5 health conditions: motor impairment, UI, sleep disturbances, falls with and without injuries, and memory deficits. These conditions were recorded from the 1998 (fourth) to 2006 (eighth) IWs for the cross-sectional cohort and from the 2000 (fifth) to 2008 (ninth) IWs subsequent to the IW in which the respective subject reported the index stroke for the longitudinal cohort. Only sleep disturbances were derived from IWs 2002 to 2008, because the corresponding questions were added to HRS in 2002.

## Statistical Analysis

Summary statistics for proportions and mean  $\pm$  SD were estimated for categorical and continuous variables, respectively. Chi-squared or *t*

tests were used to provide initial unadjusted comparisons between stroke and nonstroke subjects. To estimate the effects of stroke on any of the 5 health problems, we applied the classical covariance analysis using generalized linear modeling of each health condition. To control for possible overt confounders, nonstroke selected patients were matched to the patients with stroke on age, gender, and IW. Variables such as diabetes mellitus, hypertension, living arrangement, alcohol consumption, ethnicity, proxy respondent, psychiatric problems, and pain (further referred to as health and social confounders) were used as confounding covariates. Depending on the level of measurements, binomial and Poisson distribution were used to model the frequencies of each of the 5 health problem "outcomes" (motor impairment, UI, sleep disturbance, falling, and memory deficits). Note that the sample size and the dimensionality of covariates did not require a propensity analysis. This matching and regression modeling was considered to be sufficient for providing the adjustments.

## Results

We identified 636 individuals who had a first-ever stroke and 636 nonstroke control subjects in the 1998 to 2006 IWs. Five stroke subjects were excluded due to missing data, reducing the number of stroke subjects for the analysis to 631. The mean age  $\pm$  SD of the subjects was  $75 \pm 7$  years and 53% were female. Pain was the most frequently self-reported problem in both groups. Stroke subjects more often had pain than control subjects (37% versus 29%,  $P=0.002$ ). As expected, diabetes mellitus and hypertension were significantly more frequent in the stroke (29% and 71%, respectively) than in the nonstroke cohorts (17% and 49%, respectively,  $P<0.0001$ ), although cancer and lung disease occurred equally in both groups. Table 1 compares some observed characteristics of stroke and nonstroke cohorts.

The estimated prevalence of the health problems is presented in Table 2. In general, they were found to be more frequent in stroke survivors. For injury due to fall and some specific sleep disturbances, the difference was not significant for 1 or both sampling methods.

Comparing stroke with nonstroke subjects, the odds of having 1 of the health problems in focus are shown in Table 3. The odds of having a motor impairment were significantly higher for stroke subjects in the cross-sectional cohort. The same was observed in the longitudinal cohort, which consisted of subjects that reported having developed new motor impairment in the IWs after the stroke event.

The odds of having or developing UI were significantly higher in stroke survivors regardless of the sampling method. The same was also true for memory deficits. Overall, the odds of having or developing sleep problems were significantly higher in stroke than in control subjects regardless of the sample analyzed. In the longitudinal cohort, the odds of developing sleep disturbances after a stroke were numerically similar for the cross-sectional cohort. However, the CIs were wider, resulting in greater Type I errors and insignificant probability values. The risk of falling and thereby sustaining injuries was higher in stroke subjects in the cross-sectional cohort with odds of 1.88 and 1.77, respectively. In the longitudinal cohort, the odds for falling were also higher for stroke subjects, but injuries were not any more likely than in control subjects.

**Table 1. Unadjusted Comparisons of Stroke and Nonstroke Survivors**

	Stroke, No. (%)	Nonstroke, No. (%)	<i>P</i>
Race/ethnicity			0.26
White/non-Hispanic	478 (76%)	504 (79%)	
Black/other race	103 (16%)	94 (15%)	
Hispanic	50 (8%)	38 (6%)	
Living arrangements			0.001
Live with couple	345 (55%)	382 (60%)	
Live with other	116 (18%)	70 (11%)	
Live alone	170 (27%)	184 (29%)	
General health (self-evaluated)			<0.0001
Excellent	14 (2%)	59 (9%)	
Very good	76 (12%)	175 (28%)	
Good	187 (30%)	219 (35%)	
Fair	217 (34%)	136 (21%)	
Poor	137 (22%)	47 (7%)	
Health condition			
Diabetes mellitus	182 (29%)	110 (17%)	<0.0001
Cancer	101 (16%)	99 (16%)	0.829
Lung disease	89 (14%)	72 (11%)	0.136
Psychiatric problem	117 (19%)	90 (14%)	0.034
Vision-impaired	83 (13%)	43 (7%)	0.0001
Hearing-impaired	70 (11%)	39 (6%)	0.0016
Pain	235 (37%)	186 (29%)	0.002
Alcohol consumption, drinks/wk			0.0197
0	532 (84%)	498 (78%)	
1–3	50 (8%)	75 (12%)	
≥4	49 (8%)	63 (10%)	
Hypertension			<0.0001
Yes	445 (71%)	311 (49%)	
Yes, but not on medication	33 (5%)	45 (7%)	
Survey procedures			
Phone interview	415 (66%)	425 (67%)	0.69
Proxy respondent	92 (15%)	38 (6%)	<0.0001

## Discussion

This study of prospectively collected longitudinal information of a large cohort of elderly individuals demonstrates that stroke survivors have a markedly increased risk for developing chronic comorbid conditions. Due to these conditions, the general health of the stroke survivor declines further when compared with age- and gender-matched control subjects. Although frequencies and sometimes risks (as compared with controls) of a single health problem after stroke have been documented in the literature, this study is the first to report generalizable estimates of frequencies and risks of 5 common comorbidity domains within a large cohort that is representative of a noninstitutionalized US population.

The higher frequency of motor impairments among stroke subjects, in the cross-sectional cohort, is related to the fact that most strokes produce motor symptoms in the form of

paresis, dysmetria, ataxia, or apraxia. However, the analyses of the longitudinal cohort demonstrate that motor impairments can also develop some time after the stroke. These secondary impairments can be due to slowly accumulating cerebrovascular injury, for example, in the form of subcortical vascular encephalopathy. An alternative explanation is the learned disuse of the affected limbs.<sup>16–18</sup> Recurrent strokes do not provide a sufficient explanation for the higher odds of having a de novo motor impairment because recurrent strokes cases were excluded from the analysis. However, it is possible that subjects either had clinically silent strokes or were unaware of recurrent stroke events.<sup>19,20</sup> Peripheral neuropathies or musculoskeletal conditions are an alternative explanation for secondary motor impairments. Stroke subjects are more likely to develop neuropathy as a consequence of diabetes, which is a common risk factor for stroke and was significantly more frequent in the stroke cohort (29% versus 17% in control subjects). Hemiparetic stroke survivors are also at higher risk for musculoskeletal problems such as shoulder pain that further limits movement abilities.

Stroke survivors were found to be at greater risk for developing UI than control subjects. Previous cross-sectional analyses have shown that UI is frequent in subjects after a stroke, especially in older individuals with hemiparesis, depression, and impaired cognition.<sup>14,21</sup> Presence of UI is a predictor for mortality, dependency, and for the need of institutional care.<sup>22,23</sup> Urge incontinence or inattention to void are frequent complaints among stroke survivors.<sup>24</sup> Both types of UI are associated with the degree of white matter injury as a result of progressive subcortical vascular encephalopathy or multiple small stroke lesions, including those that are clinically silent. Inattention incontinence is specifically associated with the presence of frontoparietal lesions.<sup>24</sup>

Despite being more frequent in the cross-sectional cohort, the longitudinal cohort showed no greater risk for developing sleep disturbances than control subjects. This finding indicates that sleep problems rather coexist with the stroke than develop thereafter. Noteworthy, the odds of developing sleep problems in the longitudinal cohort showed wider CIs than the odds in the other sample. Hence, only certain subgroups of stroke survivors may develop sleep problems after the index stroke. One of these subgroups may have depression that frequently causes sleep problems. In contrast, sleep problems may pre-exist in many patients with stroke, as demonstrated by the increased frequency in the cross-sectional cohort. In these patients, pre-existing sleep apnea, the most common sleep disturbance in the elderly, may have served as a risk factor for stroke.

Falls were more frequent in stroke survivors as compared with control subjects. In a previous analysis, we found that falling after stroke was associated with advanced age, living arrangement, time from first stroke, psychiatric problems, UI, pain, motor impairment, and a history of falling and fall-related injuries.<sup>3</sup> Impaired vision, however, did not increase the risk of falling. In the longitudinal cohort of the present study, the risk of falling was elevated, but the effect did not reach statistical significance. We assume that the risk is slightly elevated, although a larger sample is needed to prove this. In contrast, it is unlikely that such methodological



**Table 2. Frequency of Health Problems for the Cross-Sectional and Longitudinal Cohorts**

Health Problem	Cross-Sectional			Longitudinal		
	Stroke, No. (%)	Nonstroke, No. (%)	P	Stroke, No. (%)	Nonstroke, No. (%)	P
Motor impairment	312 (49%)	241 (38%)	<0.0001	106 (33%)	93 (24%)	0.004
Urinary incontinence	206 (28%)	147 (20%)	<0.0001	88 (19%)	60 (11%)	0.0005
Sleep disturbance						
Trouble with falling asleep	72 (20%)	35 (9%)	<0.0001	15 (8%)	13 (5%)	0.37
Trouble with waking up at night	118 (32%)	109 (29%)	0.39	37 (19%)	35 (15%)	0.26
Trouble with waking up early	63 (17%)	50 (13%)	0.15	12 (6%)	10 (4%)	0.37
Not feeling rested in the morning	165 (45%)	130 (35%)	0.005	65 (33%)	52 (22%)	0.009
Falling accidents						
Presence of falling	281 (44%)	154 (24%)	<0.0001	106 (30%)	115 (24%)	0.038
Frequency of falling			<0.0001			0.021
0	350 (55%)	483 (76%)		245 (70%)	367 (76%)	
1–2	188 (30%)	111 (17%)		71 (20%)	91 (19%)	
≥3	93 (15%)	42 (7%)		34 (10%)	24 (5%)	
Injury due to fall	96 (15%)	54 (8%)	0.0002	31 (9%)	38 (8%)	0.62
Hip fracture due to fall	11 (2%)	4 (1%)	0.067	3 (1%)	4 (1%)	0.97
Memory deficit	50 (8%)	11 (2%)	<0.0001	36 (6%)	16 (3%)	<0.0001

reasons account for the finding that stroke survivors had no increased risk of fall-related injuries. The finding may be the consequence of reduced mobility and/or the higher care and attention a stroke survivor may receive from family members and caregivers at the time of walking.

**Table 3. Adjusted ORs of the Health Problems for the Cross-Sectional and Longitudinal Cohorts\***

Health Problem	Cross-Sectional OR (95% CI)	Longitudinal OR (95% CI)
Motor impairment	1.35 (1.05–1.73)†	1.45 (1.02–2.07)†
Urinary incontinence	1.56 (1.17–2.08)‡	1.64 (1.13–2.39)‡
Sleep disturbance		
Overall	1.25 (1.00–1.57)†	1.36 (0.99–1.89)
Trouble with falling asleep	2.07 (1.32–3.26)‡	1.26 (0.58–2.74)
Trouble with waking up early	1.15 (0.75–1.77)	1.31 (0.54–3.14)
Trouble with waking up at night	1.33 (1.02–1.72)†	1.33 (0.87–2.03)
Not feeling rested	1.33 (0.97–1.82)	1.59 (1.02–2.48)†
Falling and fall-related injury		
Overall	1.57 (1.19–2.06)‡	1.30 (0.95–1.77)
Injury due to falling	1.53 (1.11–2.11)‡	1.00 (0.61–1.62)
Frequency of falling	1.58 (1.23–2.02)‡	1.17 (0.84–1.64)
Memory deficit	4.03 (1.82–8.93)‡	2.38 (1.26–4.50)‡

\*All the data are presented as OR (95% CI), except frequency of falling that is presented as relative rate (95% CI). The numbers of stroke and nonstroke subjects for different outcomes in the longitudinal cohort are as follows: motor impairment: 319 and 395; UI: 452 and 524; memory deficit: 581 and 609; and sleep disturbance: 200 and 241.

† $P < 0.05$ .

‡ $P < 0.01$ .

Memory deficits are a frequent complaint after stroke and may be a subjective expression of fatigue or depression.<sup>25</sup> The diagnosis of dementia requires quantifiable and more objective test results. Here, we recorded memory problems only if a physician had given a diagnosis of a memory deficit in an attempt to differentiate a true memory problem from a confounding condition. Memory deficits may occur as a symptom of stroke in the posterior cerebral artery territory or it may reflect the onset of dementia. Memory problems are typically a symptom of dementia of the Alzheimer disease type but also occur in the setting of vascular dementia as a result of inattention and cognitive dysfunction.<sup>26</sup> Vascular dementia is caused by accumulating diffuse or focal ischemic brain injury and is related to cerebrovascular risk factors.<sup>27</sup> These risk factors also contribute to Alzheimer disease itself.<sup>28</sup> Alternatively, stroke may offset Alzheimer disease<sup>29</sup> by ischemia inducing an enzyme that is required for the production of the Alzheimer disease-associated Abeta protein.<sup>30</sup>

The lack of imaging studies and neurological examinations that would allow for a better assessment of stroke severity are 2 limitations of this study. In addition, biennial collection of data limited the analysis of the temporal relationship between stroke and health problems. In each interview, subjects were asked for the month and the year of their stroke, which enabled us to select new stroke cases in every IW. Questions about other health problems, however, lacked information on the specific time of onset. To ensure that the condition developed after the stroke, we had to select subjects who reported the stroke in 1 IW and the health condition in the subsequent IW (the longitudinal cohort). This may have potentially resulted in an underestimation of the de novo development of a health condition by removing subjects that had the stroke immediately followed by the health condition

within the same IW. Post hoc reports of complex conditions such as cognitive impairment may underrepresent objective evidence. Even patient-reported symptoms can underrepresent real prevalence due to pathological unawareness.<sup>31</sup> Hence, our analysis may underestimate the true prevalence of cognitive impairment after stroke. Several other common stroke-related conditions were not included in the HRS, were insufficiently answered, or not available for all subjects. For example, the HRS data set contains too many missing data points to allow for a meaningful analysis of depression. Moreover, only noninstitutionalized subjects are followed in HRS, which may have resulted in an underestimation of health problems by introducing a bias toward a healthier stroke sample, in which subjects with severe stroke living in nursing homes were excluded. Therefore, it is necessary that the data presented here be interpreted cautiously because it may only apply to a subset of stroke survivors.

### Conclusions

This analysis of the HRS data set demonstrates that stroke survivors are at markedly increased risks of developing health problems that severely impact their quality of life. Further research needs to aim at understanding the nature of the relationships and the causality between these health problems and the stroke. Rehabilitation programs, physicians, and care providers need to pay particular attention to these risks, especially to dementia, UI, and secondary motor impairments, to which the stroke survivor is exposed.

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### Disclosures

None.

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